

CLAIMS

What is claimed is:

1. A method of implementing storage virtualization on a network device of a storage area network, the method comprising:

- (a) receiving a frame or packet at a port of the network device;
- (b) determining that the frame or packet pertains to access of a virtual storage location of a virtual storage unit representing one or more physical storage locations on one or more physical storage units of the storage area network;
- (c) obtaining a virtual-physical mapping between the one or more physical storage locations and the virtual storage location; and
- (d) sending a new or modified frame or packet to an initiator or a target specified by the virtual-physical mapping.

2. The method as recited in claim 1, wherein the network device is a switch, router, iSCSI gateway, or other network node configured to perform a switching function.

3. The method as recited in claim 1, wherein the virtual storage unit comprises a VLUN or other virtual representation of storage on the storage area network.

4. The method as recited in claim 1, wherein (b), (c), and (d) are performed by logic dedicated to said port of the network device.

5. The method as recited in claim 1, wherein the frame or packet received at the port of the network device is a fibre channel frame.
6. The method as recited in claim 1, wherein the frame received at the port of the network device is an iSCSI frame.
7. The method as recited in claim 1, wherein the frame or packet received at the port of the network device comprises a read or write command.
8. The method as recited in claim 1, wherein the frame or packet received at the port of the network device comprises a SCSI read or write command.
9. The method as recited in claim 1, wherein determining that the frame or packet pertains to access of a virtual storage location comprises identifying an address of the virtual storage unit in the frame or packet from the initiator.
10. The method as recited in claim 9, wherein the address is a destination address.
11. The method as recited in claim 1, wherein determining that the frame or packet pertains to access of a virtual storage location comprises identifying an address of the port in a destination address field of the frame or packet from the target.
12. The method as recited in claim 1, wherein the virtual storage unit is a virtual logical unit and the one or more physical storage units are physical logical units.

13. The method as recited in claim 1, wherein the virtual-physical mapping is defined by a virtualization model.

14. The method as recited in claim 1, the method further comprising:
generating one or more new packets or frames or modifying the received packet or frame in a manner that replaces a destination address of the virtual storage unit with one or more destination addresses of the one or more physical storage units.

15. The method as recited in claim 1, the method further comprising:
generating a new packet or frame or modifying the received packet or frame in a manner that replaces a source address of a physical storage unit with a source address of the virtual storage unit.

16. The method as recited in claim 1, the method further comprising:
generating a new packet or frame or modifying the received packet or frame in a manner that replaces a source address of the initiator with an address of the port on the network device.

17. The method as recited in claim 1, the method further comprising:
generating a new packet or frame or modifying the received packet or frame in a manner that replaces a destination address of the port on the network device with a destination address of the virtual storage unit.

18. The method as recited in claim 1, wherein (b), (c), and (d) are performed by a processor dedicated to said port of the network device.

19. The method as recited in claim 1, further comprising requesting a lock of the one or more physical storage locations prior to submitting a read or write command to the one or more physical storage locations.

20. The method as recited in claim 19, wherein requesting a lock of the one or more physical storage locations comprises requesting a lock of the virtual storage location.

21. The method as recited in claim 19, wherein requesting a lock of the one or more physical storage locations comprises:

 sending a lock request to another port of a network device within the storage area network.

22. The method as recited in claim 21, further comprising:

 receiving a lock grant from the another port of the network device within the storage area network.

23. The method as recited in claim 22, wherein the granted lock indicates that at least one of exclusive read and write access to the virtual storage location is granted.

24. The method as recited in claim 22, further comprising:

 sending a transfer ready message to the initiator when the lock grant is received.

25. The method as recited in claim 22, further comprising:
requesting a release of the granted lock from the another port of the network device within the storage area network.
26. The method as recited in claim 25, further comprising:
receiving a notification that the granted lock has been released by the another port.
27. The method as recited in claim 25, wherein requesting a release of the granted lock is performed when the read or write command has been successfully completed.
28. The method as recited in claim 27, wherein the command has been successfully completed when a status indicating that the command was successful is received from the initiator or the target.
29. The method as recited in claim 1, wherein the frame or packet received at a port of the network device comprises a read or write command indicating an amount of memory to be read or written to, the method further comprising:
allocating the amount of memory at the network device.
30. The method as recited in claim 29, further comprising:
receiving a status from the target after the sending of the new or modified frame or packet to the target; and
when the status indicates that the command was successful, de-allocating the amount of memory at the network device.

31. The method as recited in claim 1, wherein the frame or packet received at a port of the network device comprises a read or write command, the method further comprising:

receiving a transfer ready signal from the target after the sending of the new or modified frame or packet, the transfer ready signal indicating that the target is ready to receive a transfer of data.

32. The method as recited in claim 31, further comprising:

sending a transfer ready signal to the initiator after the sending of the new or modified frame or packet, the transfer ready signal indicating that the network device is ready to receive a transfer of data from the initiator;

wherein sending the transfer ready signal to the initiator is performed prior to receiving a transfer ready signal from the target.

33. The method as recited in claim 1, wherein the frame or packet received at a port of the network device comprises a read or write command, the method further comprising:

receiving a status after the sending of the new or modified frame or packet, the status indicating whether the command was successful.

34. The method as recited in claim 33, further comprising:

sending the status to the initiator.

35. The method as recited in claim 33, further comprising:

sending a second new or modified frame or packet to an initiator or a target

specified by the virtual-physical mapping;

receiving a second status after the sending of the second new or modified frame or packet, the second status indicating whether the command was successful;

merging the status and the second status; and

sending the merged status to the initiator.

36. The method as recited in claim 33, further comprising:

determining from the status whether the command was successful; and

re-sending the new or modified frame or packet when it is determined that the command was not successful.

37. The method as recited in claim 36, further comprising:

sending the status to the initiator when it is determined that the command was successful.

38. The method as recited in claim 36, wherein the new or modified frame or packet comprises data.

39. The method as recited in claim 36, wherein the new or modified frame or packet comprises a read or write command.

40. The method as recited in claim 36, wherein the frame or packet received at a port of the network device comprises data, the method further comprising:

storing the data in a memory location;

wherein re-sending the new or modified frame or packet comprises:

obtaining the data from the memory location; and
sending a new or modified frame or packet including the obtained data
to the initiator or the target specified by the virtual-physical mapping.

41. The method as recited in claim 36, further comprising:
receiving data from the target specified by the virtual-physical mapping; and
storing the data in a memory location.

42. The method as recited in claim 41, wherein re-sending the new or modified
frame or packet comprises:
obtaining the data from the memory location; and
sending a new or modified frame or packet including the obtained data to the
initiator specified by the virtual-physical mapping.

43. The method as recited in claim 41, wherein re-sending the new or modified
frame or packet comprises sending the new or modified frame or packet to an
alternate target specified by the virtual-physical mapping, the method further
comprising:

receiving alternate data from the alternate target specified by the virtual-
physical mapping; and
comparing the alternate data with the data stored in the memory location.

44. The method as recited in claim 43, further comprising:
employing a mirror algorithm to select the alternate target.

45. The method as recited in claim 1, wherein the frame or packet received at the port of the network device and the new or modified frame or packet sent by the network device are compatible with a standard protocol.

46. The method as recited in claim 45, wherein the standard protocol is SCSI.

47. The method as recited in claim 45, wherein the frame or packet received at the port of the network device and the new or modified frame or packet sent by the network device are compatible with a type of traffic to be carried by the frames or packets.

48. The method as recited in claim 47, wherein the type of traffic is fibre channel.

49. The method as recited in claim 47, wherein the type of traffic is iSCSI.

50. The method as recited in claim 1, wherein the frame or packet received at the port of the network device comprises a SCSI read command and the new or modified frame or packet sent by the network device comprises a SCSI read command.

51. The method as recited in claim 1, wherein the frame or packet received at the port of the network device comprises a SCSI write command and the new or modified frame or packet sent by the network device comprises a SCSI write command.

52. The method as recited in claim 1, wherein the frame or packet received at the port of the network device comprises a read command and the new or modified frame

or packet sent by the network device comprises a read command.

53. The method as recited in claim 1, wherein the frame or packet received at the port of the network device comprises a write command and the new or modified frame or packet sent by the network device comprises a write command.

54. A computer-readable medium storing thereon instructions for implementing storage virtualization on a network device of a storage area network, the computer-readable medium comprising:

- (a) instructions for receiving a frame or packet at a port of the network device;
- (b) instructions for determining that the frame or packet pertains to access of a virtual storage location of a virtual storage unit representing one or more physical storage locations on one or more physical storage units of the storage area network;
- (c) instructions for obtaining a virtual-physical mapping between the one or more physical storage locations and the virtual storage location; and
- (d) instructions for sending a new or modified frame or packet to an initiator or a target specified by the virtual-physical mapping.

55. A network device of a storage area network adapted for implementing storage virtualization, comprising:

- (a) means for receiving a frame or packet at a port of the network device;
- (b) means for determining that the frame or packet pertains to access of a virtual storage location of a virtual storage unit representing one or more physical storage locations on one or more physical storage units of the storage area network;
- (c) means for obtaining a virtual-physical mapping between the one or more

physical storage locations and the virtual storage location; and

(d) means for sending a new or modified frame or packet to an initiator or a target specified by the virtual-physical mapping.

56. A network device of a storage area network adapted for implementing storage virtualization, comprising:

a processor; and

a memory, at least one of the processor and the memory being adapted for:

(a) receiving a frame or packet at a port of the network device;

(b) determining that the frame or packet pertains to access of a virtual storage location of a virtual storage unit representing one or more physical storage locations on one or more physical storage units of the storage area network;

(c) obtaining a virtual-physical mapping between the one or more physical storage locations and the virtual storage location; and

(d) sending a new or modified frame or packet to an initiator or a target specified by the virtual-physical mapping.

57. A network device for use in a storage area network supporting virtualization, the network device comprising a plurality of ports, wherein at least some of said ports comprise

(i) an interface for sending and receiving packets or frames on a storage area network; and

(ii) logic dedicated to said port of the network device, said logic for identifying frames or packets pertaining to access of a virtual storage location of a virtual storage unit representing one or more physical storage locations

on one or more physical storage units of the storage area network; and

implementing a virtual-physical mapping between the one or more physical storage locations and the virtual storage location.

58. A method of implementing storage virtualization on a network device of a storage area network, the method comprising:

(a) receiving a frame or packet at a port of the network device;

(b) obtaining information from the frame or packet pertaining to access of data stored in one or more physical locations on one or more physical storage units of the storage area network, the information identifying one or more of the physical locations or a virtual storage location representing the one or more physical storage locations;

(c) obtaining a virtual-physical mapping between the one or more physical storage locations and the virtual storage location; and

(d) sending a new or modified frame or packet to an identity specified by the virtual-physical mapping.

59. The method as recited in claim 58, wherein the new or modified frame or packet includes at least one of a source address and destination address obtained from the virtual-physical mapping.

60. The method as recited in claim 58, wherein the received frame or packet includes a source address and destination address, and wherein the obtained information includes at least one of the source address and the destination address.